JAPAN

EDICT OF GOVERNMENT

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JIS B 9717-1 (2011) (English): Safety of machinery -- Pressure-sensitive protective devices -- Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors

ISO INSIDE

安 全

The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

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JIS

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INDUSTRIAL
STANDARD

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Safety of machinery—Pressure-sensitive protective devices—Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors

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the original JIS is to be the final authority.

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by the Japan Machinery Federation (JMF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Ministers and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Safety machinery—Pressure-sensitive protective devices—Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 13856-1** published in 2001 without modifying the technical contents.

The portions underlined with dots are the matters not stated in the original International Standard.

1 Scope

This Standard specifies requirements for pressure-sensitive mats and floors normally actuated by the feet, for use as safety devices to protect persons from dangerous machinery. The minimum safety requirements for the performance, marking and documentation are given.

It covers pressure-sensitive mats and floors, regardless of type of energy used, e.g. electrical, hydraulic, pneumatic or mechanical.

This Standard covers mats and floors designed to detect:

a) persons weighing more than 35 kg:

b) and persons (e.g. children) weighing more than 20 kg.

The detection of persons weighing 20 kg or less is not covered by this Standard.

This Standard does not specify the dimensions or the configuration of the effective sensing area of pressure-sensitive mat(s) or floor(s) in relation to any particular application.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows:

ISO 13856-1 : 2001 *Safety of machinery—Pressure-sensitive protective devices—Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors* (IDT)

The symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and any revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS B 9700-1:2004 *Safety of machinery—Basic concepts, general principles for design—Part 1: Basic terminology, methodology*

NOTE : Corresponding International Standard: ISO 12100-1:2003 *Safety of machinery—Basic concepts, general principles for design—Part 1: Basic terminology, methodology* (IDT)

JIS B 9700-2:2004 *Safety of machinery—Basic concepts, general principles for design—Part 2: Technical principles*

NOTE : Corresponding International Standard: ISO 12100-2:2003 *Safety of machinery—Basic concepts, general principles for design—Part 2: Technical principles* (IDT)

JIS B 9705-1:2000 *Safety of machinery—Safety-related parts of control systems—Part 1: General principles for design*

NOTE : Corresponding International Standard: ISO 13849-1:1999 *Safety of machinery—Safety-related parts of control systems—Part 1: General principles for design* (IDT)

JIS B 9706-2:2001 *Safety of machinery—Indication, marking and actuation—Part 2: Requirements for marking*

NOTE : Corresponding International Standard: IEC 61310-2:1995 *Safety of machinery—Indication, marking and actuation—Part 2: Requirements for marking* (IDT)

JIS B 9715:2006 *Safety of machinery—Positioning of protective equipment with respect to the approach speeds of parts of the human body*

NOTE : Corresponding International Standard: ISO 13855:2002 *Safety of machinery—Positioning of protective equipment with respect to the approach speeds of parts of the human body* (IDT)

JIS B 9960-1:1999 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements*

NOTE : Corresponding International Standard: IEC 60204-1:2000 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements* (MOD)

JIS C 0025:1988 *Basic environmental testing procedures Part 2: Tests Test N: Change of temperature*

NOTE : Corresponding International Standard: IEC 60068-2-14:1984 *Environmental testing—Part 2: Tests. Test N: Change of temperature* (MOD)

JIS C 0920 *Degrees of protection provided by enclosures (IP Code)*

NOTE : Corresponding International Standard: IEC 60529 *Degrees of protection provided by enclosures (IP code)* (IDT)

JIS C 60068-2-3:1987 *Basic environmental testing procedures Part 2: Tests, Test Ca: Damp heat, steady state*

NOTE : Corresponding International Standard: IEC 60068-2-3:1969 *Basic environmental testing procedures—Part 2: Tests—Test Ca: Damp heat, steady state* (IDT)

JIS C 60068-2-6:1999 *Environmental testing—Part 2: Tests—Test Fc: Vibration (sinusoidal)*

NOTE : Corresponding International Standard: IEC 60068-2-6:1995 *Environmental testing—Part 2: Tests—Test Fc: Vibration (sinusoidal)* (IDT)

JIS C 61000-4-2 *Electromagnetic compatibility (EMC)—Part 4: Testing and measurement techniques—Section 2: Electrostatic discharge immunity test*

NOTE : Corresponding International Standard: IEC 61000-4-2 *Electromagnetic compatibility (EMC)—Part 4-2: Testing and measurement techniques—Electrostatic discharge immunity test* (IDT)

JIS C 61000-4-3 *Electromagnetic compatibility (EMC)—Part 4-3: Testing and measurement techniques—Radiated, radio-frequency, electromagnetic field immunity test*

NOTE : Corresponding International Standard: IEC 61000-4-3 *Electromagnetic compatibility (EMC)—Part 4-3: Testing and measurement techniques—Radiated, radio-frequency, electromagnetic field immunity test* (IDT)

JIS C 61000-4-4 *Electromagnetic compatibility (EMC)—Part 4-4: Testing and measurement techniques—Electrical fast transient/burst immunity test*

NOTE : Corresponding International Standard: IEC 61000-4-4 *Electromagnetic compatibility (EMC)—Part 4-4: Testing and measurement techniques—Electrical fast transient/burst immunity test* (IDT)

JIS C 61000-4-5 *Electromagnetic compatibility (EMC)—Part 4-5: Testing and measurement techniques—Surge immunity test*

NOTE : Corresponding International Standard: IEC 61000-4-5 *Electromagnetic compatibility (EMC)—Part 4-5: Testing and measurement techniques—Surge immunity test* (IDT)

JIS C 61000-6-2:1992 *Electromagnetic compatibility (EMC)—Part 6-2: Generic standards—Immunity for industrial environments*

NOTE : Corresponding International Standard: IEC 61000-6-2 *Electromagnetic compatibility (EMC)—Part 6-2: Generic standards—Immunity for industrial environments* (MOD)

ISO 6431:1992 *Pneumatic fluid power—Single rod cylinders, 1 000 kPa (10 bar) series, with detachable mountings, bores from 32 mm to 320 mm—Mounting dimensions*

IEC 60439-1:1999 *Low-voltage switchgear and controlgear assemblies—Part 1: Type-tested and partially type-tested assemblies*

IEC 61000-6-3 *Electromagnetic compatibility (EMC)—Part 6-3: Generic standards—Emission standard for residential, commercial and light-industrial environments*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS B 9700-1**: 2004 and the following apply.

3.1 pressure-sensitive mat

safety device that detects a person standing on it or who steps on to it comprising a sensor(s) that responds to the application of pressure, a control unit and one or more output signal switching device(s)

See figure 1 and **3.26.5** of **JIS B 9700-1**: 2004.

NOTE : In a pressure-sensitive mat the effective sensing area is deformed locally when the sensor(s) is actuated.

3.2 pressure-sensitive floor

safety device that detects a person standing on it or who steps on to it comprising a sensor(s) that responds to the application of pressure, a control unit and one or more output signal switching device(s)

See figure 1 and **3.26.5** of **JIS B 9700-1**: 2004.

NOTE : In pressure-sensitive floor the effective sensing area is moved as a whole when the sensor(s) is actuated.

3.3 sensor

that part of the pressure-sensitive mat or pressure-sensitive floor that contains an effective sensing area on which the application of an actuating force causes the signal from the sensor to the control unit to change state

3.4 effective sensing area

that part of the top surface area of the sensor or a combination of sensors of the pressure-sensitive mat or pressure-sensitive floor within which a response to an actuating force will take place

3.5 control unit

device that responds to the condition of the sensor(s) and controls the state of the output signal switching device

NOTE : It may also monitor the integrity of the pressure-sensitive mat or pressure-sensitive floor (see reference to categories in **JIS B 9705-1**: 2000) and it may contain facilities to process a reset signal. The control unit may be integrated with the machine control system.

3.6 output signal switching device

that part of the pressure-sensitive mat or pressure-sensitive floor that, when the sensor or monitoring function means is actuated, responds by producing an OFF state

NOTE: The output signal switching device may be integrated with the machine control system.

3.7 actuating force

any force that produces pressure on the effective sensing area to create an OFF state in the output signal switching device

3.8 reset

function which permits an ON state in the output signal switching devices, provided certain conditions be met

3.9 ON state of output signal switching device(s)

state in which the output circuit(s) is complete and the flow of current or fluid is possible

3.10 OFF state of output signal switching device(s)

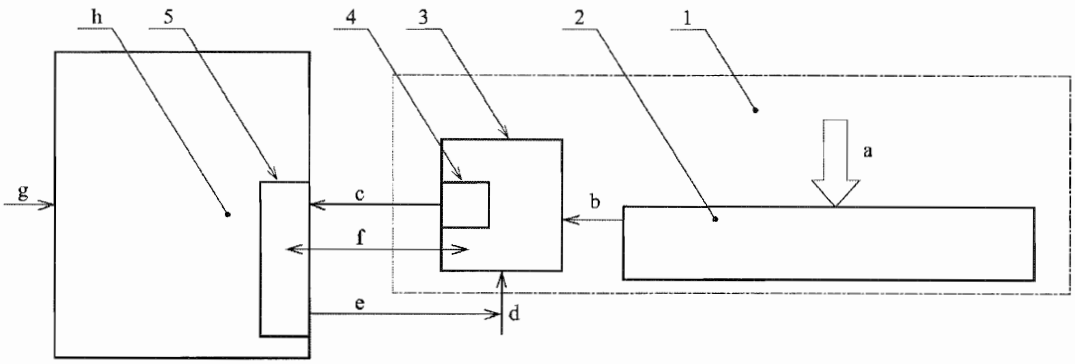
state in which output circuit(s) is broken and the flow of current or fluid is interrupted

3.11 response time

time between the start of the application of a force to the effective sensing area and the start of the OFF state of the output signal switch device (see **4.3**)

3.12 dead zone

that part of the top surface area of the sensor outside the effective sensing area



1 Pressure-sensitive mat or floor output signal processing
2 Sensors
3 Control unit – may be integrated with the machine control system
4 Output signal switching device(s) – may be integrated with the machine control system
5 Part of the machine control system for pressure sensitive mat/pressure sensitive floor output signal processing
a Actuating force
b Sensor output
c ON state/OFF state signal
d Manual reset signal (where appropriate alternative to g)
e Reset signal from machine control system (where appropriate)
f Monitoring signals (optional)
g Manual reset signal to the machine control system (where appropriate alternative to d)
h Machine control system(s)

Figure 1 Pressure-sensitive mat or pressure-sensitive floor interfaced with a machine

4 Requirements

4.1 General

Pressure-sensitive mats and pressure-sensitive floors shall be able to detect a person who is standing on, or who steps on to the effective sensing area.

4.2 Actuating force

4.2.1 Single sensor (see **7.4.1** and **7.4.2** for test method)

The pressure-sensitive mat or pressure-sensitive floor shall respond to the actuating forces stated in table 1 when the test piece (see figure 2) is applied over the effective sensing area at a maximum speed of 2 mm/s within the operating temperature range.

Test pieces 1, 2 and 3 apply to pressure-sensitive mats and pressure-sensitive floors designed to detect persons weighing more than 35 kg. Test piece 4 shall additionally be applied to pressure-sensitive mats and pressure-sensitive floors designed to detect persons (e.g. children) weighing more than 20 kg.

Table 1 Actuating force

Application	Test piece		Actuating force
	Number	d mm	N
For pressure-sensitive mats and pressure-sensitive floors designed to detect persons weighing more than 35 kg	1	11	300
	2	80	300
	3	200	600
Additional test for pressure-sensitive mats and pressure-sensitive floors designed to detect persons (e.g. children) weighing more than 20 kg	4	40	150

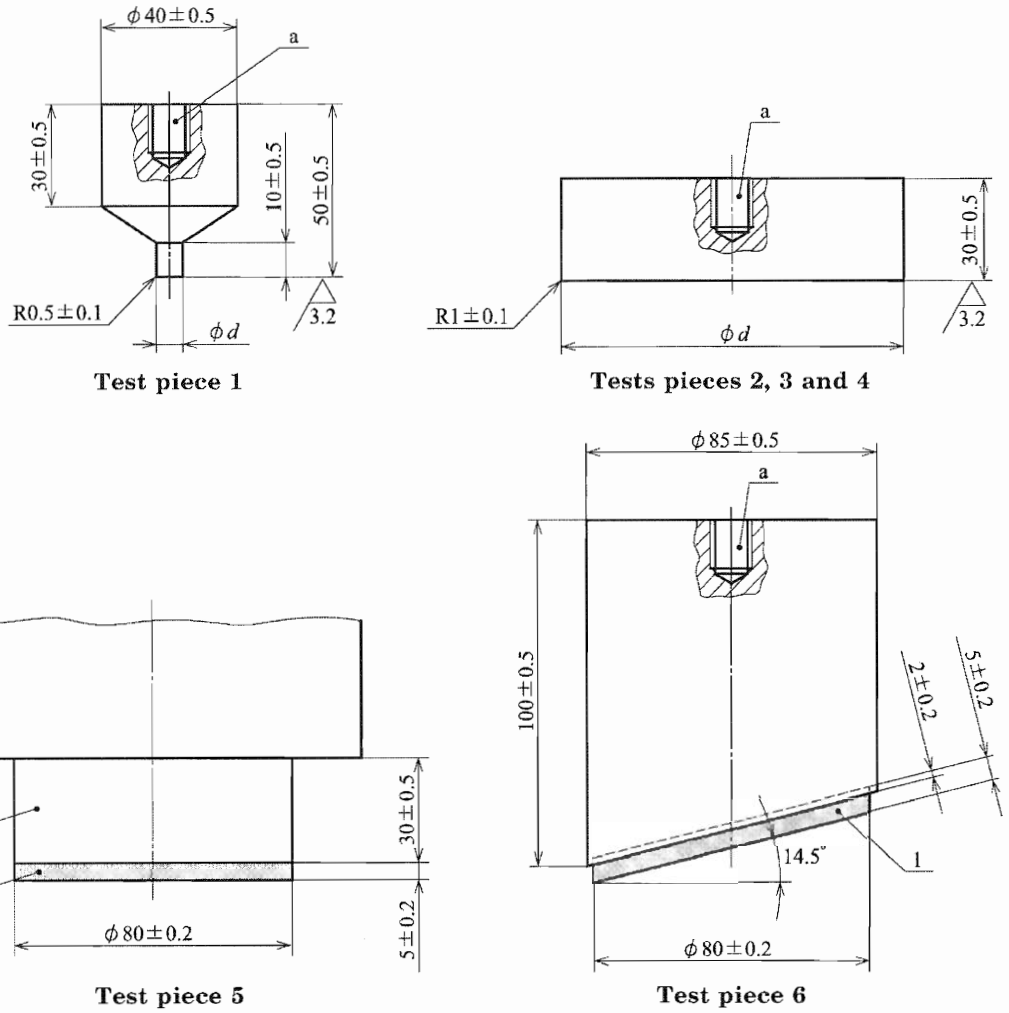
4.2.2 Combinations of sensors (see **7.4.3** and **7.4.4** for test methods)

Where an effective sensing area is built up of more than one sensor, joints and junctions shall fulfil the requirements of **4.2.1** except that only test piece 2 in table 1 applies to pressure-sensitive mats and pressure-sensitive floors designed to detect persons weighing more than 35 kg.

Where pressure-sensitive mats and pressure-sensitive floors are designed to detect persons (e.g. children) weighing 20 kg or more only test pieces 2 and 4 shall apply.

For other parts of the effective sensing area, **4.2.1** shall apply (see table 1).

Unit: mm



1 Rubber "shoe", 60 Shore A±5 Shore A, fixed with adhesive

2 Steel

a Mounting proposal only

For d see table 1.

Figure 2 Test pieces

4.3 Response time (see 7.5 for test method)

The response time shall be stated by the manufacturer and shall not exceed 200 ms over the operation temperature range. The response time is the time between **a**) and **b**) where:

a) is when a test piece vertically touches the effective sensing area at a velocity of 0.25 m/s;

b) is the start of the OFF state of the output signal switching device (see figures A.1, A.2 and A.3).

NOTE : The 200 ms limit is specified to prevent the safety device from being defeated by the application of short stepping impulses.

4.4 Static loading (see **7.6** for test method)

4.4.1 After the application of a static force of 2 000 N ± 50 N within the effective sensing area through test piece 2 (see figure 2), for a period of 8 h, the output signal switching device shall change state within 2 min of the removal of the force and the deformation shall be no more than 2 mm depth at the lowest part of the top surface after 1 h.

4.4.2 After the application of a static force of 750 N ± 20 N within the effective sensing area of another location to that used in **4.4.1** through test piece 1 (see figure 2) for a period of 8 h, the deformation shall be no more than 2 mm at the lowest part of the top surface after 1 h.

4.5 Number of operations (see **7.7** for test method)

4.5.1 A pressure-sensitive mat or pressure-sensitive floor shall perform its function for the typical expected number of operations.

4.5.1.1 The expected number of operations for the pressure-sensitive mat or pressure-sensitive floor is 100 000 operations in each of five locations (500 000 operations in total). If the effective sensing area consists of a combination of sensors, this requirement shall apply to combination of sensors.

4.5.1.2 In addition, the expected number of operations for the sensor alone is a further one million operations in one other location.

4.5.2 When the requirements of **4.4** and **4.5.1** have been met, the pressure-sensitive mat or pressure-sensitive floor shall still meet the requirements of **4.2** and **4.3**.

4.6 The output state of the sensor (see **7.8** for test method)

The sensor output signal shall change to a value or state which causes the output signal switching device(s) to change to the OFF state when any actuating force is applied to the effective sensing area. This value or state shall maintain the output signal switching device(s) in the OFF state until the actuating force is removed (see figures A.1, A.2 and A.3).

4.7 Response of output signal switching device(s) to the actuating force (see **7.9** for test method)

4.7.1 General

When any actuating force is applied to the effective sensing area, the output signal switching device(s) shall change from an ON state to an OFF state. The output signal switching device shall remain in the OFF state for at least as long as the actuating force is applied.

4.7.2 Device with reset

For a pressure-sensitive mat or pressure-sensitive floor with reset, the reset signal shall be manually applied either directly to the control unit of the safety device or alternatively via the machine control system (see figure 1).

The reset shall perform the following two functions.

a) **Start inhibit interlock** At power ON the output signal switching device(s) shall remain in the OFF state until the reset signal is applied.

b) **Re-start inhibit interlock** After the actuating force has been removed, the output of the output signal switching device(s) shall only change to an ON state after the application of a reset signal.

If the reset signal is applied continuously before or whilst the actuating force is applied, the output of the output signal switching device(s) shall not change to an ON state when the actuating force is removed (see figures A.1 and A.2).

The reset signal shall control either the output of the sensor and the output signal switching device(s) (see figure A.1) or it shall control the output of the output signal switching device(s) only (see figure A.2).

4.7.3 Device without reset

For a pressure-sensitive mat or pressure-sensitive floor without reset, the output signal of the output signal switching device(s) shall change to an ON state at power ON after the actuating force has been removed (see figure A.3).

NOTE : If a device without reset is used, then the reset function should be provided in the machine control system (see **5.4** of **JIS B 9705-1** : 2000).

4.8 Access for maintenance (see **7.10** for test method)

Where access is required to the interior of any part of the pressure-sensitive mat or pressure-sensitive floor, it shall be possible only by means of a key or tool. Any means of securing an enclosure shall be captive.

4.9 Adjustments (see **7.11** for test method)

There shall be no method of adjustment by the user to actuating force and response time.

Where the supplier states that sub-assemblies of the pressure-sensitive mat or pressure-sensitive floor can be individually replaced, this shall be possible without reducing the overall performance of the pressure-sensitive mat or pressure-sensitive floor and without the need for adjustment.

4.10 Connections (see **7.12** for test method)

The correct alignment of plugs/sockets shall be made clear by either type, shape, marking or designation (or a combination of these).

Where components of different configurations existing within the pressure-sensitive mat or pressure-sensitive floor are interchangeable, incorrect placement or exchange of these components shall not cause a failure to danger.

If a sensor or subsystem is connected by a plug and socket, removal or disconnection of the sensor or subsystem at the plug and socket from or within the control unit shall cause the output signal switching device(s) to go to an OFF state.

4.11 Environmental conditions (see **7.13** for test method)

The pressure-sensitive mat or pressure-sensitive floor shall continue to operate in the environmental conditions given below or in any wider range stated by the manufacturers.

4.11.1 Temperature range

The pressure-sensitive mat or pressure-sensitive floor shall comply with requirements of **4.2.1** and **4.3** over a temperature range of +5 °C to +40 °C.

NOTE: Extended environmental temperature ranges can be −25 °C to +40 °C and +5 °C to +70 °C.

4.11.2 Humidity

The requirements for humidity shall be in accordance with test Ca of **JIS C 60068-2-3** : 1987, for a period of four days.

4.11.3 Electromagnetic compatibility

The pressure-sensitive mat or pressure-sensitive floor shall continue in normal operation when subjected to level/class 3 in accordance with table 4 (see **7.13.4**).

4.11.4 Vibration

The requirements for vibration shall apply to the control unit and the output signal switching device(s) only and shall be in accordance with **JIS C 60068-2-6** : 1999:

a) frequency range 10 Hz to 55 Hz;

b) displacement 0.15 mm;

c) 10 cycles per axis;

d) sweep rate one octave per minute.

NOTE : Special requirements for the sensor are not practicable because of the variation in sizes and shapes of sensors. Sensors are normally fixed to the ground in which case vibration is not normally critical. Where a sensor is fixed to a part of a machine, the effects of vibration should be considered. See Annex B.

4.12 Power supply

4.12.1 Electrical power supply (see **7.14** for test method)

The pressure-sensitive mat or pressure-sensitive floor shall meet the requirements of **4.3** of **JIS B 9960-1** : 1999.

4.12.2 Non-electrical power supply

For non-electrical power supplies, the manufacturer shall state the nominal supply level and the permissible range of tolerance within which normal operation will be maintained.

Where over-pressure protective devices are not provided, over-pressure variations outside the nominal range shall not result in a failure to danger.

Variations below the operating range shall not result in a failure to danger (see also **EN 982**:1996 and **EN 983**:1996).

NOTE : No methods of test have been established for such equipment.

4.13 Electrical equipment (see 7.15 for test method)

4.13.1 General

The electrical equipment (components) of the pressure-sensitive device shall:

a) conform to **JIS** and/or International Standards where they exist;

b) be suitable for the intended use;

c) be operated within their specified ratings.

4.13.2 Protection against electric shock

Protection against electric shock shall be provided in accordance with **6.1**, **6.2** and **6.3** of **JIS B 9960-1**:1999.

4.13.3 Protection against overcurrent

Overcurrent protection shall be provided in accordance with **7.2.1**, **7.2.3**, **7.2.7**, **7.2.8** and **7.2.9** of **JIS B 9960-1**:1999.

NOTE : Information may need to be given to the user of the pressure-sensitive device as to the maximum rating of fuses, or setting of an overcurrent protective device for the circuit(s) connected to the output connection points of the output signal switching device(s).

4.13.4 Pollution degree

The electrical equipment shall be suitable for pollution degree 2 in accordance with **6.1.2.3** of **IEC 60439-1**.

4.13.5 Clearance, creepage distances and isolating distances

The electrical equipment shall be designed and constructed in accordance with **7.1.2** of **IEC 60439-1**.

4.13.6 Wiring

The electrical equipment shall be wired in accordance with **7.8.3** of **IEC 60439-1**.

4.14 Enclosure (see 7.16 for test method)

4.14.1 Sensor

The sensor enclosure shall meet a minimum standard of IP54 (in accordance with **JIS C 0920**).

When the manufacturer specifies that the sensor can be immersed in water, the minimum enclosure level of the sensor shall be IP67 (in accordance with **JIS C 0920**).

4.14.2 Control unit and output signal switching device enclosure

The control unit enclosure shall meet a minimum standard of IP54 (in accordance with **JIS C 0920**). Where the control unit is designed for mounting in another control equipment enclosure and the enclosure is to a minimum IP54 (in accordance with **JIS C 0920**), the control unit shall be to a minimum of IP2X (in accordance with **JIS C 0920**). The enclosure containing the output signal switch device(s) shall also meet these requirements.

4.15 Categories for safety-related parts of control systems in accordance with JIS B 9705-1:2000 (see 7.17 for test method).

4.15.1 Pressure-sensitive mats and pressure-sensitive floors shall meet the requirements of the category for which they are specified and marked. These categories are defined in **JIS B 9705-1**:2000.

4.15.2 The sensor, control unit and output signal switching device shall meet the requirements of category 1 as a minimum. To meet category 1, the system shall, as a minimum, meet the requirements of this Standard and the relevant requirements of **JIS B 9705-1**:2000.

4.15.3 Electronic control units shall meet the requirements of category 2 as a minimum.

NOTE 1 The sensor, control unit and output signal switching device may each have different categories.

NOTE 2 The fault conditions of the sensor and its connections that can be monitored should be taken into account when evaluating the category of the control unit.

NOTE 3 It is not possible at the time of writing this Standard for the majority of sensors to meet all the requirements specified in the categories 2, 3 and 4, in particular when considering mechanical damage and long-term deterioration.

4.16 Sensor fixings (see 7.1.2 for test method)

The sensor shall be provided with a means for fixed permanent location.

4.17 Tripping (see 7.1.2 for test method)

When there is a danger that a person can trip on the outside edge(s) of a sensor or sensor covering, a suitable ramp shall be provided. The slope of the ramp shall not exceed 20° from the horizontal. Its existence shall be identified by contrasting colours or marking. The ramp shall not create a physical obstruction or other hazard.

Where there is a combination of sensors and/or additional coverings, provision shall be made to minimize the tripping hazard at joints and junctions between the sensors.

NOTE : There is at present no standard covering this subject, but **JIS B 9713-2** can be taken into account when the test method is agreed.

4.18 Slipperiness and softness of the sensor top surfaces (see **7.18** for test method)

Provision shall be made on the top surface of the sensor to minimize slipping under the expected operating conditions.

NOTE : There is at present no standard covering this subject, but **JIS B 9713-2** can be taken into account when the test method is agreed.

4.19 Additional coverings of top surfaces of sensor(s) (see **7.19** for test method)

The overall requirements of this Standard shall apply to sensor(s) which are fitted with additional or alternative coverings, e.g. protective sheets (see Annex C).

4.20 Failure due to blocking or wedging (see **7.20** for test method)

There shall be no risk of failure due to build-up of dirt or swarf under the sensor or combination of sensors or their associated connecting parts.

5 Marking (see 7.1.2 for test method)

5.1 General

The pressure-sensitive mat or pressure-sensitive floor shall be marked in accordance with **6.4** of **JIS B 9700-2**:2004 and **18.1** of **JIS B 9960-1**:1999.

All labels and marking shall be securely fixed and durable for the expected lifetime of the part of the pressure-sensitive mat or pressure-sensitive floor to which it is attached (see **JIS B 9706-2**).

5.2 Marking of the control unit

The control unit label(s) shall also contain the following information, or indicate where this information can be found:

a) the category according to **JIS B 9705-1**:2000, specifying whether it applies to the control unit only or to the system as a whole;

b) the response time;

c) with or without reset;

d) part number.

5.3 Marking of the sensor

The sensor label shall also contain the following information or indicate where this information can be found:

a) the category according to **JIS B 9705-1**:2000;

b) if suitable for detecting persons (e.g. children) weighing more than 20 kg;

c) the response time;

d) the part number.

5.4 Marking of other components

Component parts of the pressure-sensitive mat or pressure-sensitive floor that can be replaced in accordance with the information for use shall be identifiable.

6 Information for use

6.1 General

Information to be supplied to the user and the way it is presented shall comply with clause **6** of **JIS B 9700-2**:2004.

6.2 Instructions for use (see **7.1.2** for test method)

6.2.1 General

The instructions for use (e.g. handbook) shall include all the information necessary for safe installation, use and maintenance of the device as listed in **6.2.2** to **6.2.6**. See Annexes B and D. The instructions for use shall include the following.

6.2.2 Application

6.2.2.1 Detailed description of the device(s) and a warning

"Categories in accordance with **JIS B 9705-1**:2000 for pressure-sensitive mats and pressure-sensitive floors on machines are stated in type C standards."

Where no type C standard exists, a risk assessment shall be carried out, following the guidelines described in **5.3** of **JIS B 9700-1**:2004 and in **JIS B 9702** which show the importance of selecting the safety device with appropriate category in accordance with Annex B of **JIS B 9705-1**:2000.

6.2.2.2 Device features

a) The category(ies) in accordance with **JIS B 9705-1**:2000;

   1) the limits of size and shape for individual sensors including effective sensing area;

   2) the limits of combination of numbers and sizes of sensor which can be used with one control unit;

   3) connections between components.

b) The limits of connection length between individual components of the pressure-sensitive mat or pressure-sensitive floor and types of connections.

   e.g. cable specification and plugs and sockets;

   1) the fitting arrangements – how sensors can be combined;

   2) the fixing arrangements of the sensor and control unit;

   3) the mass of the sensor per square meter, and the mass of the control unit;

   4) the sensor additional covering details (where applicable);

   5) the response time;

6) the power supply requirements;

7) the control unit enclosure specifications in accordance with **JIS C 0920**;

8) the switching capability of the output signal switching device(s);

9) the configuration(s) of the output signal switching device(s);

10) the suitability for detecting walking aids e.g. walking sticks and walking frames.

c) The formula for calculating the required effective sensing area in relation to the hazard location shall be provided. Typical examples of the application of the formula shall be given (see **A.5.2** of **JIS B 9715**:2006).

d) The range of applications and conditions for which the device(s) is/are intended or approved including the category it complies with. Examples of unsuitable applications should also be given;

1) schematic representation of the safety functions and examples of machine control interface circuit diagrams;

2) the rating, characteristics and location of all input/output terminals;

3) guidance regarding chemical, physical and environmental resistance (e.g. resistance to solvents, permissible weight loading, operation temperature range, permissible power supply variation etc.);

4) guidance regarding suitability for wheeled vehicles which may be starting, braking or turning on the surface of the sensor;

5) whether the device(s) is/are designed with or without reset in accordance with **4.7**.

NOTE : If a device without reset is used, then the reset function should be provided in the machine control system (see **5.4** of **JIS B 9705-1**: 2000).

6.2.3 Packaging, transportation, handling and storage

a) description of packaging and methods of unpacking to prevent damage to the device(s);

b) transportation and handling methods to prevent damage or personal injury;

c) storage requirements (e.g. lay flat, temperature range etc.).

6.2.4 Installation and commissioning

a) instruction that the instruction handbook should be read in full before any installation work is attempted;

b) requirements regarding the surface on which the sensor is to be mounted;

c) installation method including tooling required (see Annex B for guidance);

d) design features of the effective sensing area and the dead zones and how they should be optimized during installation (including drawings where appropriate);

e) schedule of tests to enable commissioning to be carried out after installation in order to establish that the device(s) is/are functioning;

f) warning that the overall safety of the machine and its safety device(s) depends on the integrity of the interface between them;

g) instruction to check that the category(ies) of the device according to **JIS B 9705-1**: 2000 is/are appropriate.

6.2.5 Operating instructions

a) purpose and method of operation of actuator(s) and indicators e.g. starting and re-starting;

b) information regarding limits of use;

c) instructions for fault identification.

6.2.6 Maintenance

a) warning that the maintenance section of the handbook should be read in full before any maintenance is attempted;

b) tasks which require a definite technical knowledge or particular skills and hence should be carried out exclusively by suitably trained, skilled persons;

c) specification of type and frequency of inspection and maintenance;

d) instructions for cleaning;

e) information, e.g. drawings and diagrams enabling trained personnel to carry out fault finding, servicing and repair;

f) details of tests required after replacement of parts to establish that the device(s) function(s) as designed;

g) warning that all covers, clips, edging strips and fastenings removed during maintenance shall be refitted after maintenance and that if such parts are not correctly refitted, the requirements for the device(s) may not be met;

h) list of user replaceable parts specified in sufficient detail to maintain a system which complies with this Standard;

i) warning that only those parts approved by the manufacturer may be replaced by the user and that if non-approved spares are used or non-approved modifications are made, the device(s) may not function to the designed requirements;

j) name and address of manufacturer and competent service organization.

6.2.7 Training requirements

Recommendations for the minimum training requirements of user's personnel including installers, operators and maintenance/inspection staff to ensure that the device(s) is/are installed, used and maintained to comply with this Standard.

7 Testing

7.1 General

7.1.1 The type tests 1 to 17, described in **7.4** to **7.20**, shall determine whether pressure-sensitive mats or pressure-sensitive floors meet the requirements of this Standard. The tests shall be carried out on a ready-to-use pressure-sensitive mat or pressure-sensitive floor. Unless otherwise specified, these tests shall be carried out at 23 °C ± 5 °C.

The following are some of the factors which can affect the performance:

a) size of the sensor surface area;

b) top or additional covering material of the effective sensing area;

c) combination of sensors;

d) length of the interconnecting cables or tubes.

The tests described in **7.4** to **7.20** shall be carried out with the least favourable combination of factors for each test.

7.1.2 Where no special test methods are specified, verification shall be by inspection.

7.2 Sensor test sample

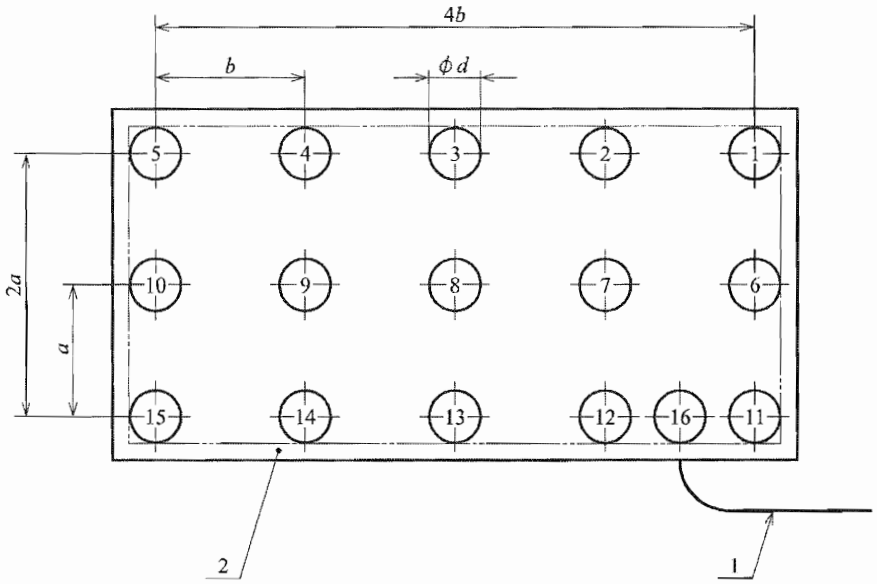
The sample(s) shall have a sensor(s) with dimensions of at least 1 000 mm × 500 mm.

If the pressure-sensitive mat or pressure-sensitive floor has only one sensor, two sensors will be required for the tests. One sensor is used to verify the requirements of **4.2**, **4.3**, **4.4** and **4.5.1.1** (100 000 operations at each of five locations giving 500 000 operations in total). The other sensor is used to verify the requirements of **4.5.1.2** (one million operations at one location) and **4.10**.

If the pressure-sensitive mat or pressure-sensitive floor is designed with an effective sensing area built up from a combination of sensors, then a number of sensors for connection with one control unit are required. The combination of sensors will be used to verify the requirements of **4.2** and **4.3**. The sensor that is selected for the locations 1 to 16 marked on figure 3 is used for verification of the requirement **4.4** and, together with one other sensor, the requirement of **4.5.2**. One of the remaining sensors is used to verify the requirements **4.5.1.2** (one million operations at one location) and **4.10**.

7.3 Test pieces for load tests

These tests shall be carried out with the test pieces as shown in figure 2. The test pieces shall be manufactured from aluminium alloy except as specified in figure 2.



1 Connecting cable (example)

2 Dead zone

d Diameter of the respective test piece

Figure 3 Test locations of the effective sensing area of a single sensor

7.4 Test No. 1 – Actuating force (requirements see 4.2)

7.4.1 Single sensor at ambient temperature

Test pieces and actuating forces given in table 1 shall be applied perpendicularly to the effective sensing area in all locations shown in figure 3 plus five points considered to be critical to meet the actuating force requirements (see Annex C). In figures 3, 4 and 5 the diameters of the circles shown for the locations represent the diameter of the relevant test piece.

Test piece 4 shall only be applied if the pressure-sensitive mats or pressure-sensitive floors are designed to defect persons (e.g. children) weighing more than 20 kg. Additional tests shall be carried out at one random location with test piece 2 at the limits of the specified power supply variations.

7.4.2 Single sensor at operating temperature range (or temperature range as stated by the manufacturer)

Test pieces and actuating forces given in table 1 shall be applied perpendicularly to the effective sensing area in locations 1, 8 and 16 shown in figure 3, at the limits of the range, starting at the highest temperature. The sensor shall reach temperature equilibrium before it is tested.

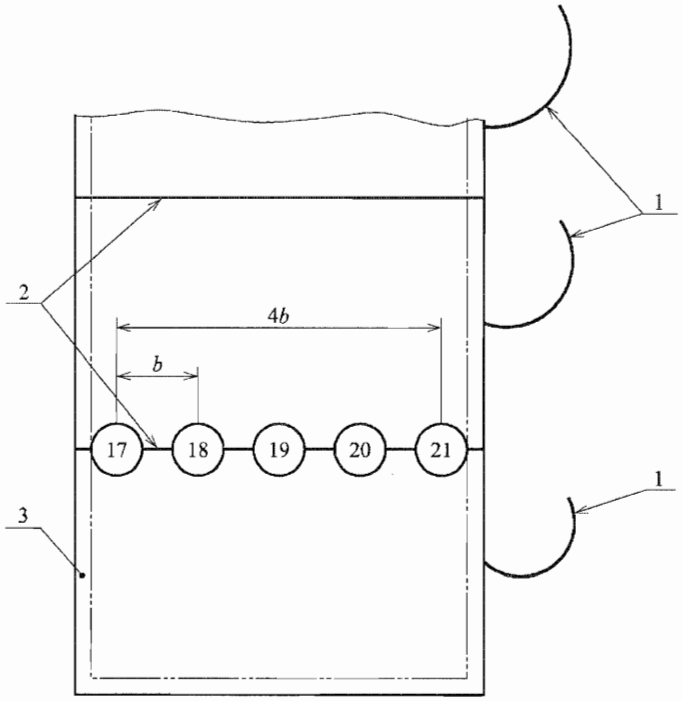
If the actuating force required to actuate the output signal switching device is, in all cases, more than 10 % below the forces shown for the relevant test piece in table 1, the pressure-sensitive mat shall be assumed to give similar results over its whole area. If the force is not within this limit but is below the level shown in table 1, then the test shall be carried out at the limits of temperature range on all the locations on the sensors as shown in figure 3 and critical points of **7.4.1**.

7.4.3 Combination of sensors at ambient temperature

7.4.3.1 Where two or more sensors are combined to constitute one effective sensing area, the same tests as in **7.4.1** shall be carried out on one sensor at the ambient temperature. In addition, the following test pieces shall be applied perpendicular to the effective sensing area at locations on joints as shown in figure 4 or at locations on a joint and a junction as shown in figure 5.

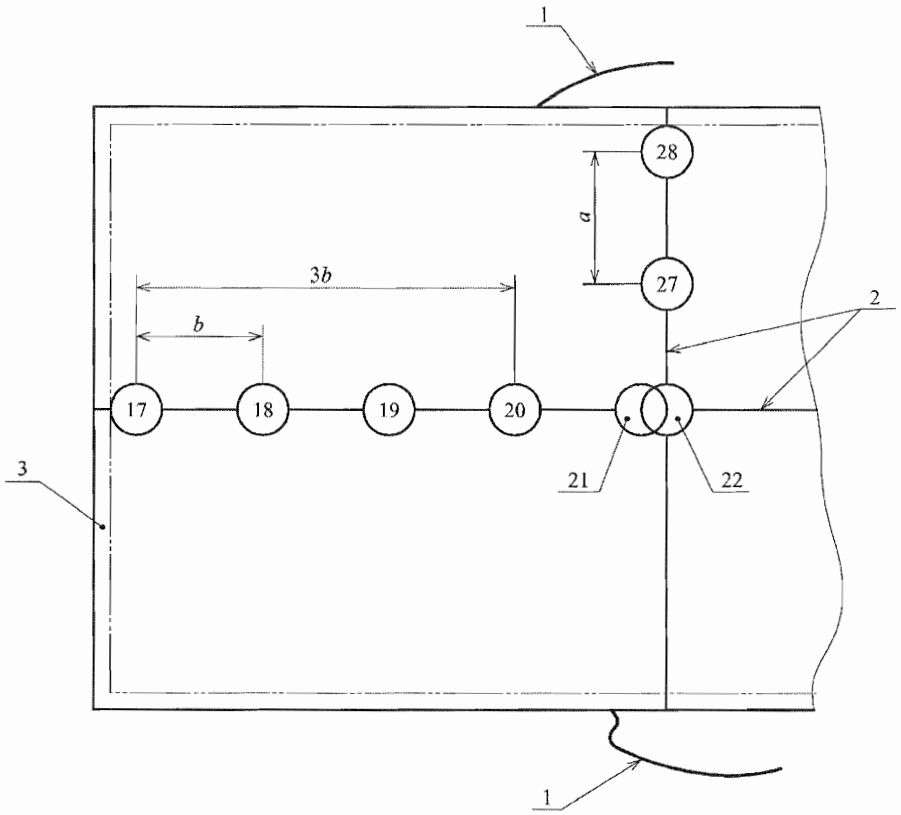
7.4.3.2 For pressure-sensitive mats and pressure-sensitive floors designed to detect persons weighing more than 35 kg, use test piece 2 and actuating force as given in table 1.

7.4.3.3 For pressure-sensitive mats and pressure-sensitive floors designed to detect persons (e.g. children) weighing more than 20 kg, use test pieces 2 and 4 and actuating forces as given in table 1.



1 Connecting cable (example)
2 Joint line
3 Dead zone

Figure 4 Test locations on the joints between sensors



1 Connecting cable
2 Joint line
3 Dead zone

Figure 5 Test locations on the joints and on a junction between sensors

7.4.4 Combinations of sensors at operating temperature range (or temperature range as stated by the manufacturer)

7.4.4.1 Where two or more sensors are combined to constitute one effective sensing area, the same tests as in **7.4.2** shall be carried out on one sensor at the limits of the temperature range.

In addition, the following test pieces shall be applied perpendicular to the effective sensing area at locations 17, 19 and 21, as shown in figure 4, at the temperature limits or at locations 17, 19, 22, 27 and 28 only, as shown in figure 5, at the temperature limits. The sensors shall reach temperature equilibrium before they are tested.

7.4.4.2 For pressure-sensitive mats and pressure-sensitive floors designed to detect persons weighing more than 35 kg, use test piece 2 and actuating force as given in table 1.

7.4.4.3 For pressure-sensitive mats and pressure-sensitive floors designed to detect persons (e.g. children) weighing more than 20 kg, use test pieces 2 and 4 and actuating forces as given in table 1.

7.5 Test No. 2 – Response time (requirements see **4.3**)

For this test the sensor configuration which is expected to give the longest response time shall be used.

The response time is measured with test piece 7 (see figure 6) of $(30^{+0.5}_{0})$ kg mass and diameter d of test piece 2 of table 1. If the pressure-sensitive mat or pressure-sensitive floor is designed to detect persons (e.g. children) weighing more than 20 kg, the test is carried out with test piece 8 (see figure 6) of $(15^{+0.5}_{0})$ kg mass and a diameter d of test piece 4 of table 1.

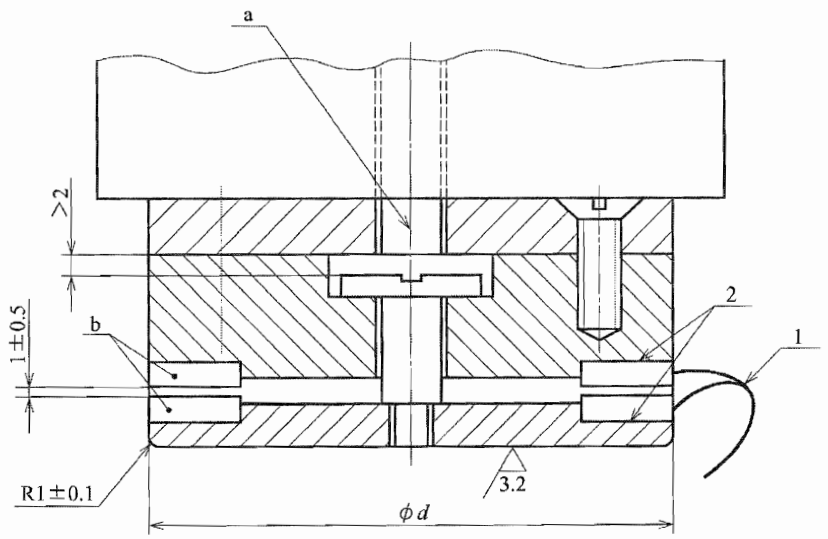
The test pieces (see figure 6) are constructed so that when the lower part of the test piece touches the effective sensing area with a force less than 10 N, an electrical signal is produced. The test pieces shall be applied to the effective sensing area perpendicularly at a velocity of $(0.25^{0}_{-0.03})$ m/s. The time between the initiation of the electrical signal from the test piece and the start of the OFF state of the output signal switching device shall be measured. The tests shall be carried out at locations 1, 4, 8 and 16 (as shown in figure 3) and at a random location which is expected to give the longest response time.

When the combination of sensors is arranged according to figure 4, the tests shall be carried out on the sensor at locations 1, 4, 8 and 16 (as shown in figure 3), which is expected to give the longest response time because of its location within the combination and at locations 17 and 19 (as shown in figure 4).

When the combination of sensors is arranged as shown in figure 5, the tests shall be carried out on the sensor at locations 1, 4, 8 and 16 (as shown in figure 3), which is expected to give the longest response time because of its location within the combination and at locations 17, 19, 22, 27 and 28 (as shown in figure 5).

The tests shall be carried out at all the above indicated locations at 23 °C ± 5 °C. At the limits of the specified temperature range, the tests shall be carried out only at locations 1 and 16 (as shown in figure 3) and 17 (as shown in figure 4) or 17, 22 and 27 (as shown in figure 5).

Unit: mm



1 Connecting cable
2 Insulation
a Mounting proposal only
b Conducting
d Diameter

Figure 6 Test pieces 7 and 8 to measure the response time

7.6 Test No. 3 – Static loading (requirements see 4.4)

NOTE : It is possible that pressure-sensitive floors are designed to be integrated with a machine. In this case it is not possible to carry out the tests required for pressure-sensitive mats.

7.6.1 A static force of 2 000 N ± 50 N shall be applied perpendicular to the effective sensing area through test piece 2 (as shown in figure 2) for 8 h on a sensor at a random location within 120 mm of the edges of the effective sensing area.

The output signal switching device shall change to an ON state 2 min after the force has been removed (if the system has a reset, it has to be actuated). The deformation of the effective sensing area surface through the test piece shall be measured one hour after removing the force. The depth of the deformation shall not exceed 2 mm measured from the lowest part of the top surface.

7.6.2 A static force of 750 N ± 20 N shall be applied perpendicular to the effective sensing area through test piece 1 (as shown in figure 2) for 8 h at another location within 120 mm of the edges of the effective sensing area.

The output signal switching device shall change to an ON state 2 min after the force has been removed (if the system has a reset, it has to be actuated). The deformation of the effective sensing area surface through the test piece shall be measured one hour after removing the force. The depth of the deformation shall not exceed 2 mm measured from the lowest part of the top surface.

7.6.3 Within 30 min of measuring the deformation in **7.6.1** and **7.6.2**, the actuating force and response time shall be checked at the location where the test has been performed. For testing the actuating force and the response time, test piece 2 (see table 1) shall be applied. Test piece 4 shall also be applied when the pressure-sensitive mats and pressure-sensitive floors are designed to detect persons (e.g. children) weighing more than 20 kg.

7.7 Test No. 4 — Number of operations (requirements see 4.5)

7.7.1 The tests of requirement **4.5.1.1** (100 000 operations at each of five locations) shall be carried out as shown on figures 7 and 8 using test piece 6 (see figure 2). The actuation shall be achieved by supplying a working pressure of 0.38 MPa ± 0.02 MPa to the pneumatic cylinder in accordance with **ISO 6431**:1992 with a 50 mm diameter and a 125 mm stroke. This working pressure shall also exist at the valve intake (cylinder control) at the moment when the test piece impacts the effective sensing area.

This can be achieved by a valve with 6 mm nominal diameter that is directly connected to the pneumatic cylinder or through a short air line. This line shall have a nominal diameter $\geq$ 10 mm and a length $<$ 200 mm. A flow control valve shall be installed in the downstream side to achieve an impact velocity of $(0.55^{+0.05}_{0})$ m/s of the test piece.

Where the effective sensing area consists of a combination of sensors, test piece 6 shall be applied at location 8, 16, 23, 24 and 26 as shown on figures 9 and 10. One of these locations has to coincide with the location where the test **7.6.1** has been performed.

For this test, the operations through the test piece 6 (see figure 2) at the effective sensing area shall be in the two directions shown on figure 7 to 10. In each direction, 50 000 operations shall be performed at each location (giving 100 000 operations in total). During this test, test piece 6 shall be applied 20 times to each location consecutively until a total of 50 000 operations has been completed at each location and in each direction.

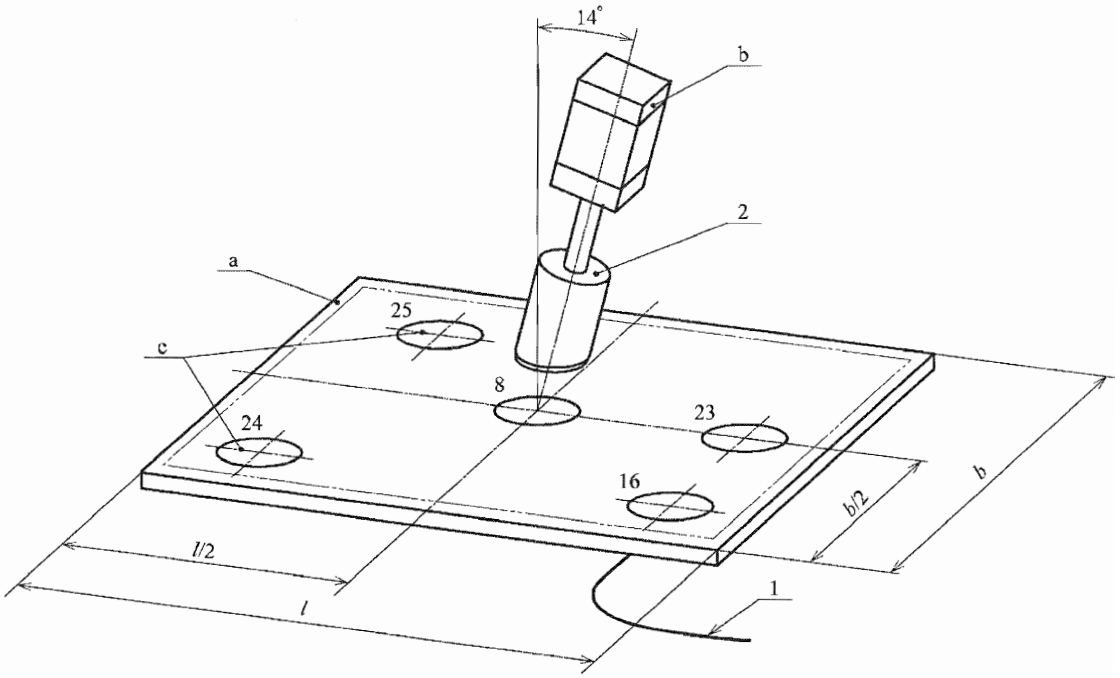
During this test, the output signal switching device is connected to the sensor(s) and the pressure-sensitive mat or pressure-sensitive floor has to be operating. The sensor(s) shall be fixed with fastening elements specified by the manufacturer in the manual.

7.7.2 The test of requirement **4.5.1.2** (one million operations in one location) shall be carried out on a single sensor with the output signal switching device disconnected, by applying test piece 5 with a mass of 75 kg ± 1 kg (see figure 2) at a vertical impact velocity of $(0.55^{+0.05}_{0})$ m/s. The test piece shall be applied one million times at a random location on a line 120 mm inside the edges of the effective-sensing area.

The test equipment surface which supports the sensor shall not move more than 1 mm in a vertical direction while the test is in progress.

During this test, the time of one interval of an actuation shall be $(4.0^{+1.0}_{0})$ s. During each interval, test piece 5 shall touch the effective sensing area for 0.8 s ± 0.2 s.

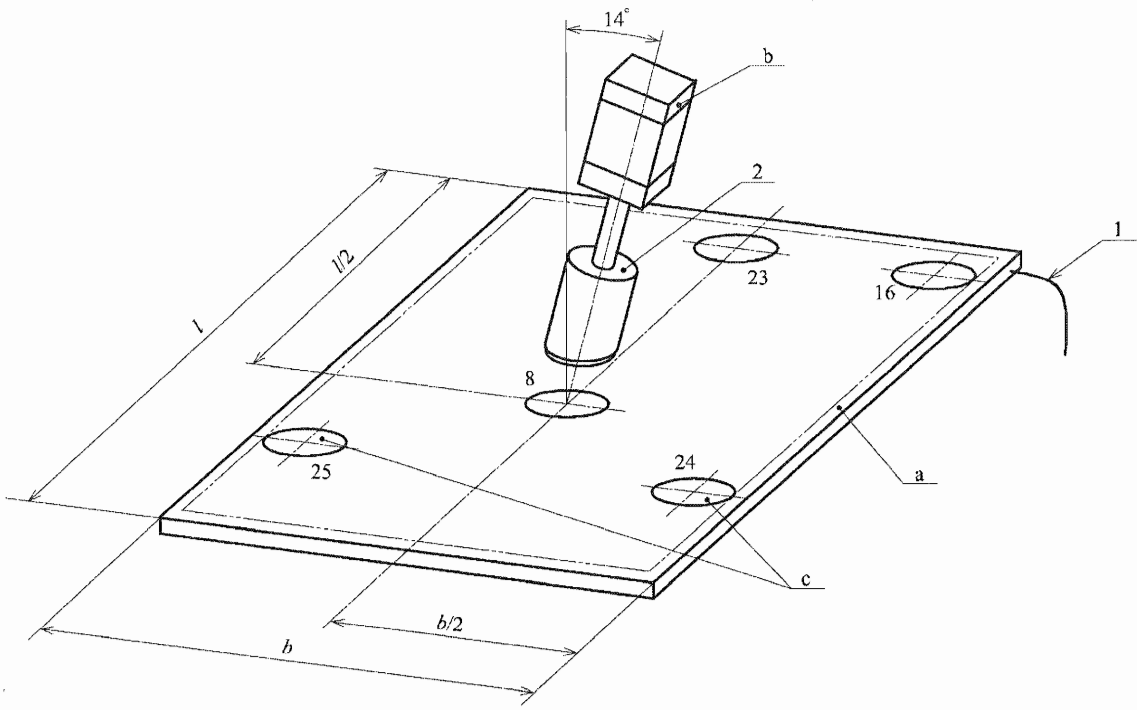
Unit: mm



1 Connecting cable (example)
2 Test piece 6 (see figure 2)
a Dead zone
b Inside diameter of the pneumatic cylinder 50 mm, stroke 125 mm in accordance with **ISO 6431**:1992
c Random location
l Length of sensor
b Width of sensor

Figure 7 Arrangement of the pneumatic cylinder and locations for the test "Number of operations", applied to a single sensor (horizontal component of the force acting parallel to the longest edge of the sensor)

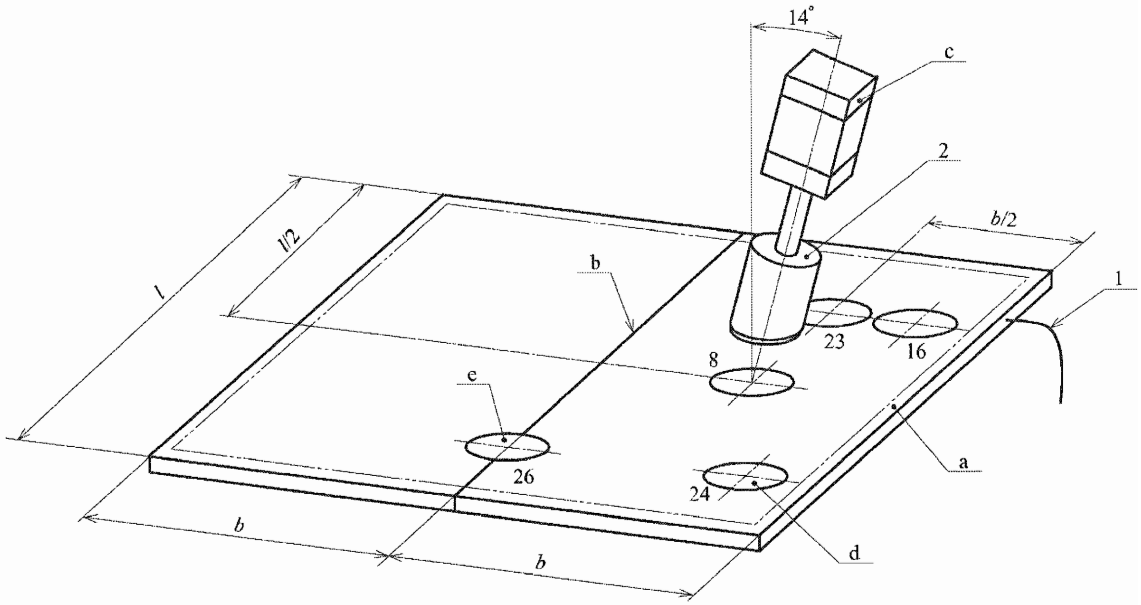
Unit: mm



1 Connecting cable (example)
2 Test piece 6 (see figure 2)
a Dead zone
b Inside diameter of the pneumatic cylinder 50 mm, stroke 125 mm in accordance with **ISO 6431** : 1992
c Random location
l Length of sensor
b Width of sensor

Figure 8 Arrangement of the pneumatic cylinder and locations for the test "Number of operations" applied to a single sensor (horizontal component of the force acting parallel to the shortest edge of the sensor)

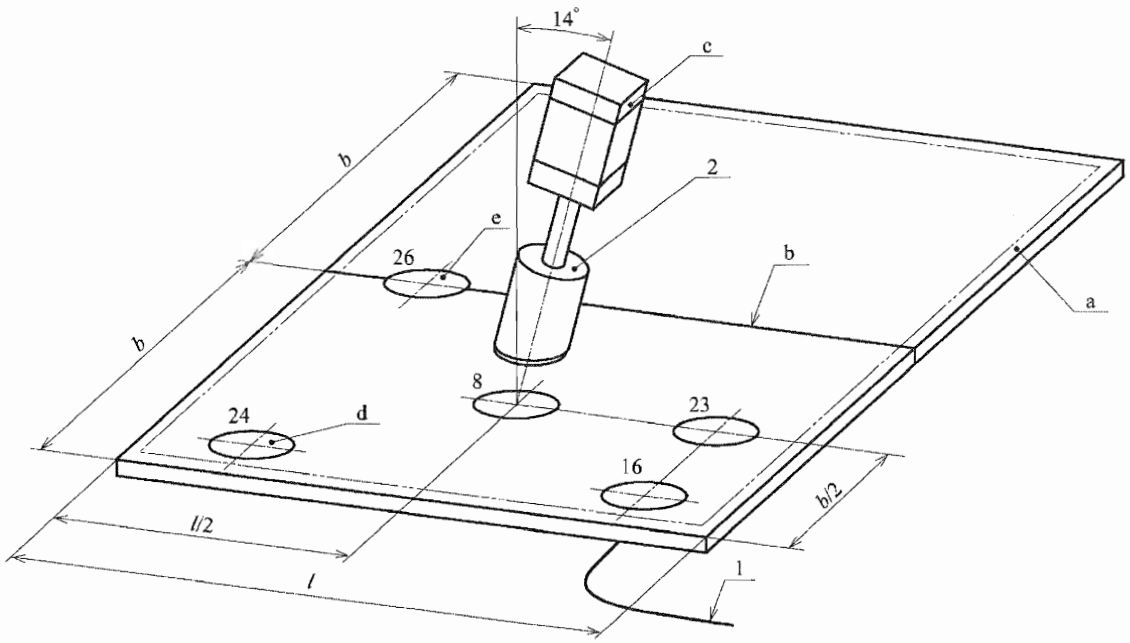
Unit: mm



1 Connecting cable (example)
2 Test piece 6 (see figure 2)
a Dead zone
b Joint line
c Inside diameter of pneumatic cylinder 50 mm, stroke 125 mm in accordance with **ISO 6431**:1992
d Random location
e Random location on joint line
l Length of sensor
b Width of sensor

Figure 9 Arrangement of the pneumatic cylinder and locations for the test "Number of operations" applied to a combination of sensors (horizontal component of the force acting parallel to the longest edge of the sensor)

Unit: mm



1 Connecting cable (example)
2 Test piece 6 (see figure 2)
a Dead zone
b Joint line
c Inside diameter of pneumatic cylinder 50 mm, stroke 125 mm in accordance with **ISO 6431**:1992
d Random location
e Random location on joint line
l Length of sensor
b Width of sensor

Figure 10 Arrangement of the pneumatic cylinder and locations for the test "Number of operations", applied to a combination of sensors (horizontal component of the force acting parallel to the shortest edge of the sensor)

7.7.3 The function of the pressure-sensitive mat or pressure-sensitive floor shall be checked by testing the actuating force using test piece 2 (see figure 2) and the response time using test piece 7 (see figure 6) at the locations where the tests of **7.7.1** and **7.7.2** have been performed.

If the pressure-sensitive mat or pressure-sensitive floor is designed to detect persons (e.g. children) weighing more than 20 kg, additional tests for the actuating force using test piece 4 (see figure 2 and table 1) and for the response time using test piece 8 (see figure 6) shall be applied to the same locations as the previous tests.

7.8 Test No. 5 – Output state of the sensor (requirements see 4.6)

Test piece 2 (see figure 2) applying the actuating force as given in table 1 shall be applied perpendicular to the effective sensing area in one random location for a minimum time of 8 h. The output state of the sensor shall change state when this

actuating force is applied to it and remain in that state until the actuating force is removed as shown in figures A.1, A.2 and A.3.

During this test, the output level of the sensor shall not change to a level which allows the output signal switching device to revert to an ON state.

7.9 Test No. 6 — Response of output signal switching device to the actuating force (requirements see 4.7)

The interaction of separate functions as shown in figures A.1, A.2 and A.3 shall be tested using test piece 2 (see figure 2) and the actuating force as given in table 1 applied perpendicular to the effective sensing area in one random location at room temperature.

7.10 Test No. 7 — Access for maintenance (requirements see 4.8)

Testing shall be by inspection.

7.11 Test No. 8 — Adjustments (requirements see 4.9)

Testing shall be by inspection and by replacing the sub-assemblies which are authorized by the manufacturer.

7.12 Test No. 9 — Connections (requirements see 4.10)

All dissimilar plug-in components that are interchangeable within the pressure-sensitive mat or pressure-sensitive floor shall be interchanged one at a time and each plug-in component shall be disconnected with power ON.

7.13 Test No. 10 — Environmental conditions (requirements see 4.11)

7.13.1 Functional test

At the beginning and at the end of the following tests, the function of the pressure-sensitive mat and pressure-sensitive floor shall be verified using test piece 2 (see figure 2) and the actuating force as given in table 1, applied perpendicularly at a speed of 100 mm/s ± 5 mm/s to the effective sensing area in one random location at room temperature. During this procedure the output signal switching device shall change from an ON state to an OFF state.

7.13.2 Test No. 10.1 — Temperature range (requirements see 4.11.1)

The test, in accordance with table 2, shall be carried out over the temperature range stated by the manufacturer.

Table 2 Temperature range

Test procedure	Remarks
JIS C 0025: 1988 Test N	Pressure-sensitive mat or pressure-sensitive floor is connected to the power supply

For heating and cooling, the rate of change of temperature shall be 0.8 °C ± 0.3 °C per min over the whole temperature range. During the test, in accordance with **JIS C 0025**, the functional test according to **7.13.1** shall be carried out at 1 min intervals. This test can be carried out using a sensor with a smaller effective sensing area than

that indicated in **7.2**. The dimensions of the effective sensing area shall, however, not be less than 400 mm × 200 mm.

7.13.3 Test No. 10.2 — Humidity (requirement see **4.11.2**)

The requirements concerning the resistance to humidity shall be verified in accordance with table 3 for a period of four days.

Table 3 Humidity

Test procedure	Remarks
JIS C 60068-2-3:1987 Test Ca	Pressure-sensitive mat or pressure-sensitive floor is not connected to the power supply

After the test of the resistance to humidity, the insulation resistance in accordance with **8.2.2.6** or **IEC 60439-1**: 1999 has to be verified.

7.13.4 Test No. 10.3 — Electromagnetic compatibility (immunity) (requirements see **4.11.3**)

Safety-related requirements shall be verified by reference to **IEC 61000-6-3** and **IEC 61000-6-2** only. Immunity shall be verified for the following three switching states according to the test procedures given in table 4 and with the indicated characteristic values given in the specifications in **7.13.1**:

— pressure-sensitive mat or pressure-sensitive floor with supply energy;

— pressure-sensitive mat or pressure-sensitive floor with supply energy with applied actuating force;

— pressure-sensitive mat or pressure-sensitive floor with supply energy, after removal of the actuating force and prior to the execution of the reset.

Table 4 Electromagnetic compatibility

Kind of testing and characteristic values	Test procedures
Surge installation class 3	**JIS C 61000-4-5** power, earth and input/output lines
Electrical fast transients (burst), Level 3	**JIS C 61000-4-4** duration of test: 2 min. power, earth and input/output lines
Electrostatic discharge, Level 3	**JIS C 61000-4-2**
Radiated, radio-frequency electromagnetic field, Level 3	**JIS C 61000-4-3**

7.13.5 Test No. 10.4 — Vibration (requirements see **4.11.4**)

The requirements concerning vibration at the control unit and the output signal switching device only shall be verified in accordance with table 5. At 10 s intervals during this test, there will be a function test in accordance with, **7.13.1** as at the beginning and end of the test.

Table 5 Vibration

Test procedure	Remarks
JIS C 60068-2-6: 1999	Pressure-sensitive mat or pressure-sensitive floor is connected to the power supply

7.14 Test No. 11 — Electrical power supply (requirements see **4.12.1**)

The requirements of **4.12.1** shall be verified in accordance with the requirements of clause 4 of **JIS B 9960-1**: 1999

7.15 Test No. 12 — Electrical equipment (requirements see **4.13**)

It shall be verified that the electrical equipment meets the requirements listed in **4.13**.

7.16 Test No. 13 — Enclosure (requirements see **4.14**)

All enclosures shall be tested in accordance with the requirements of **JIS C 0920**.

7.17 Test No. 14 — Categories for safety-related parts of control systems in accordance with JIS B 9705-1:2000 (requirements see **4.15**)

An assessment shall be carried out to confirm that the category claimed for the equipment is in accordance with **JIS B 9701-1**: 2000.

7.18 Test No. 15 — Slipperiness and softness of the sensor top surfaces (requirements see **4.18**)

This requirement shall be tested by inspection until special tests are available, but **JIS B 9713-2** can be taken into account when test method is agreed.

7.19 Test No. 16 — Additional coverings of top surfaces of sensor(s) (requirements see **4.19**)

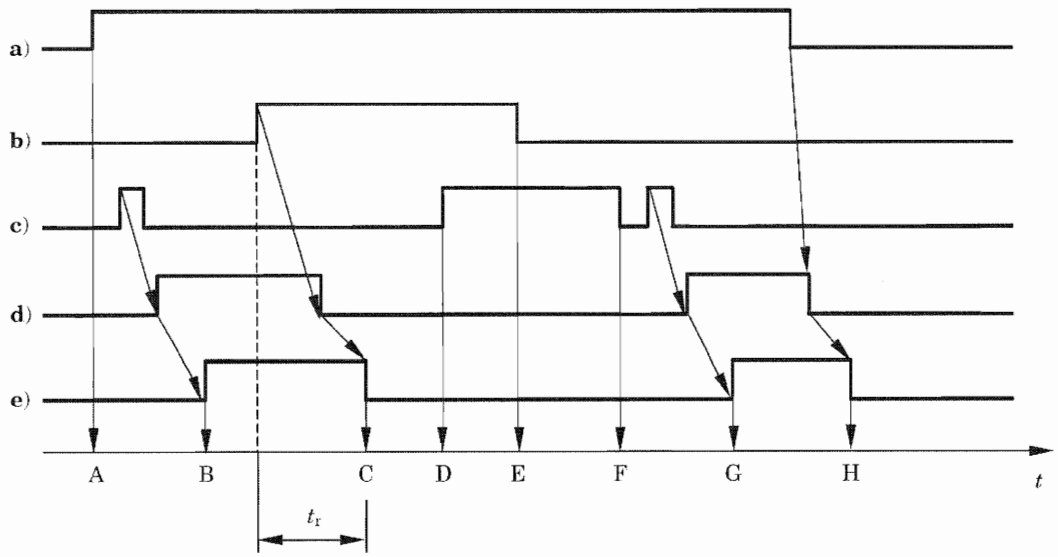
This test shall be carried out by selecting the least favourable combination of factors for each test in accordance with **7.1** to **7.18**.

7.20 Test No. 17 — Failure due to blocking or wedging (requirements see **4.20**)

This requirement shall be verified by inspection and if in doubt by a specific test.

Annex A (normative)
Timing diagrams for devices with and without reset

The following figures A.1 to A.3 illustrate the response of the output signal switching device to the actuating force (see **4.7**).



a) Power to mat or floor
b) Actuating force
c) Reset signal
d) Sensor output
e) Output of the output signal switching device(s)

t = time
t_r = response time

Figure A.1 Relationship between actuating force, reset signal, and output (sensor output initiated by reset function)

A Power to the device (mat or floor) **a)** is ON; sensor output **d)** and output of the output signal switching device **e)** remain OFF because the device has not been reset **c)**.

B Reset signal **c)** present. Output of the device **e)** is turned ON because sensor output **d)** is turned ON due to operation of reset button **c)** without actuating force **b)** on the pressure-sensitive mat or pressure-sensitive floor.

C Output of the device **e)** is OFF because the sensor output **d)** is turned OFF due to actuating force **b)** on the mat or floor sensor.

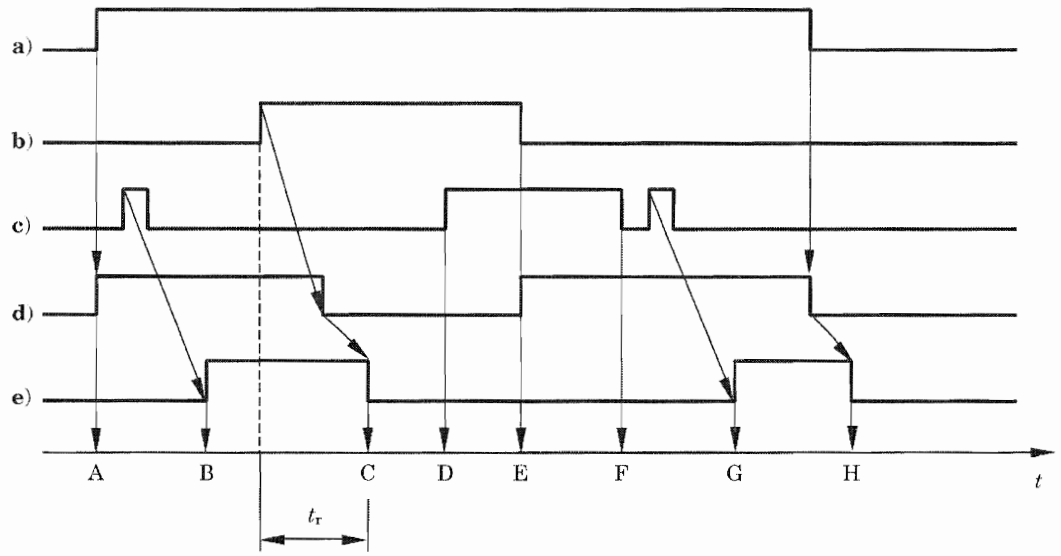
D Reset signal **c)** present. Operation of reset button **c)** has no effect on output of the device **e)** as long as an acting force **b)** is present on the sensor; device remains OFF.

E Acting force **b)** removed from the mat or floor sensor; the sensor output **d)** or output of the device **e)** remains OFF even though the reset signal **c)** is still present.

F Even when reset signal **c)** removed in E, the output of the output signal switching device **e)** remains OFF.

G Reset signal **c**) present. Output of the device **e**) is turned ON because sensor output **d**) is turned ON due to operation of reset button **c**) without actuating force **b**) on mat or floor sensor.

H Power to the device (mat or floor) **a**) is OFF; sensor output **d**) and device output **e**) are turned OFF.



a) Power to mat or floor
b) Actuating force
c) Reset signal
d) Sensor output
e) Output of the output signal switching device(s)

t = time
t_r = response time

Figure A.2 Relationship between actuating force, reset signal and output (sensor output independent of reset function)

A Power to the device (mat or floor) **a**) is ON; output of the device **e**) remains OFF because the device has not been reset **c**). Sensor output **d**) is turned ON when the power is turned ON.

B Reset signal **c**) present without acting force **b**) on mat or floor sensor. Output of the device **e**) is turned ON due to the operation of reset button **c**) as long as the sensor output **d**) is turned ON.

C Actuating force **b**) on the mat or floor sensor. The sensor output **d**) is turned OFF which also turns output of the device **e**) OFF.

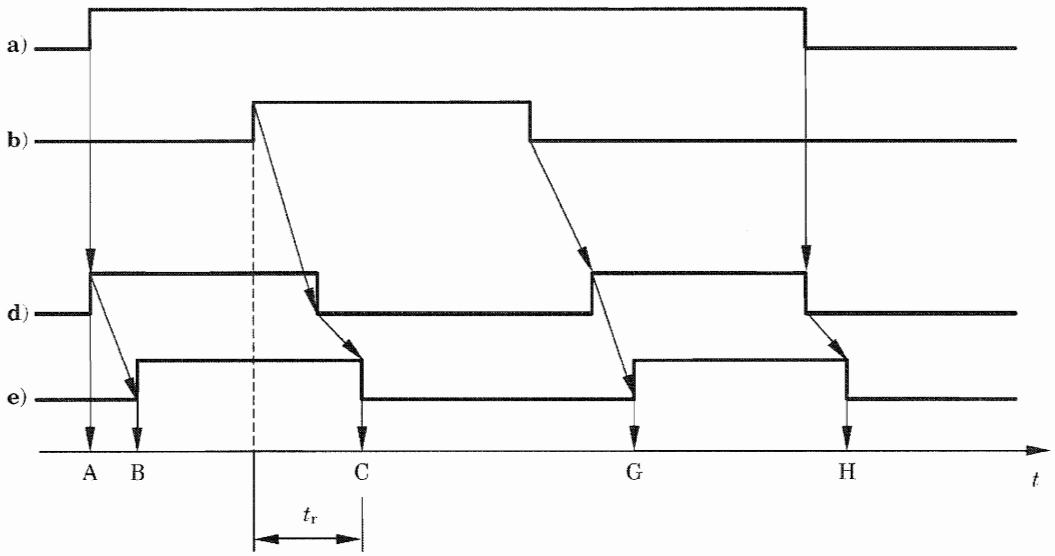
D Reset signal **c**) present. Operation of reset button **c**) has no effect on output of the device as long as an acting force **b**) is present on the mat or floor sensor; output of the device **e**) remains OFF.

E Actuating force **b**) removed from the mat or floor sensor; the sensor output **d**) is turned ON but the output of the device **e**) remains OFF even though the reset signal **c**) is still present.

F Even though reset signal **c**) removed in E, the output of the output signal switching device **e**) remains OFF.

G Reset signal **c**) present without actuating force **b**) on the mat or floor sensor. Output of the device **e**) is turned ON due to operation of reset button **c**) as long as the sensor output **d**) is turned ON.

H Power to the device (mat or floor) **a**) is OFF; sensor output **d**) and output of the device **e**) are turned OFF.



a) Power to mat or floor
b) Actuating force
d) Sensor output
e) Output of the output signal switching device(s)

t = time
t_r = response time

Figure A.3 Relationship between actuating force and output for devices without reset

A Power to the device (mat or floor) **a**) is ON; sensor output **d**) is turned ON.

B Output of the device **e**) is turned ON because there is no actuating force **b**) on the mat or floor sensor and sensor output **d**) is turned ON.

C Output of the device is OFF because sensor output **d**) is OFF due to actuating force **b**) on the mat or floor sensor.

G Output of the device **e**) is turned ON because sensor output **d**) in ON due to actuating force **b**) being removed from the sensor.

H Power to the device (mat or floor) **a**) is OFF; sensor output **d**) and device output **e**) are turned OFF.

Annex B (informative)
Application notes

B.1 General

These notes should be regarded as recommendations to manufacturers for inclusion in the instruction handbook. When selecting pressure-sensitive mats or pressure-sensitive floors, a plan should be prepared which contains, amongst other information, the following recommendations.

B.2 Mounting surface (location)

The surface quality should meet the requirements stated by the manufacturer, e.g. irregularities may impair the function of the sensor pressure-sensitive mats and pressure-sensitive floors and therefore should be reduced to an acceptable minimum.

Cable entry points to sensors should be considered in order to ensure:

a) that controls are situated in appropriate positions;

b) that no tripping hazards are created due to connecting cables;

c) that no dead zones are created in areas to be protected, e.g. sensors may have a dead zone adjacent to the entry point of connecting cables.

B.3 Size of the sensor

When considering the sensor dimensions, the minimum distance to the hazard should be taken into account according to the requirements of **JIS B 9715**:2006.

B.4 Selection criteria

The following list contains some features which should be considered when selecting the system:

a) use as a single device, or in combination with other devices;

b) ability to combine sensors;

c) avoidance of dead zones;

d) frequency of operating cycles and lifetime of the system;

e) output signal switching device switching capacity;

f) static loading, such as parts of machinery resting on the surface;

g) loading by wheeled traffic, e.g. driving, braking and turning;

h) temperature and humidity;

i) rapid variations in temperature and humidity;

j) effects of chemicals such as oils, solvents, cutting fluids and combinations of these fluids;

k) effects of flooding, e.g. when cleaning and in case of leakages;

l) effect of foreign bodies such as swarf, dust and sand;

m) additional covering for the sensor;

n) stress due to vibration, shocks, etc.;

o) high electro-magnetic interference, such as can be found on certain types of welding equipment and radio transceivers;

p) supply voltage fluctuations outside the specification in accordance with **JIS B 9960-1**, which may be caused by he switching of large loads;

q) sensitivity levels which can differ from the requirements of this Standard;

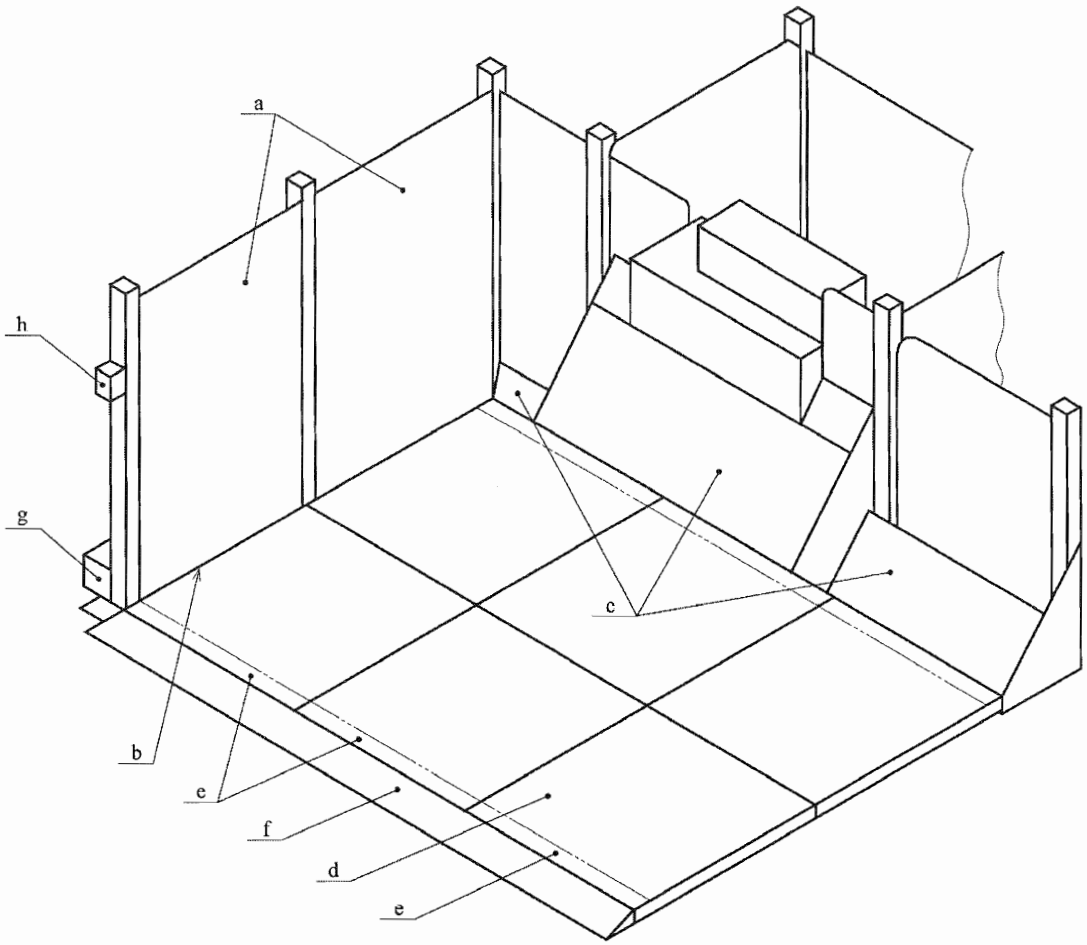
r) the need for reset and the location of the reset button;

s) required control category of pressure-sensitive mat or pressure-sensitive floor in accordance with **JIS B 9705-1**:2000;

t) need for special wording, signs and marking;

u) sensor fixing.

B.5 Comparison between good and poor installation design



a Additional fixed guards are fitted, which prevent access to the danger zone of the machinery.

b The fixed guard is arranged and designed in such a way that there is no access to the danger zone between the fixed guard and the sensors. The fixed guard permits access to the danger zone through the sensors only.

c A sloping cover plate prevents the operator standing at the side of the effective sensing field and in the danger zone.

d Sensors are properly installed.

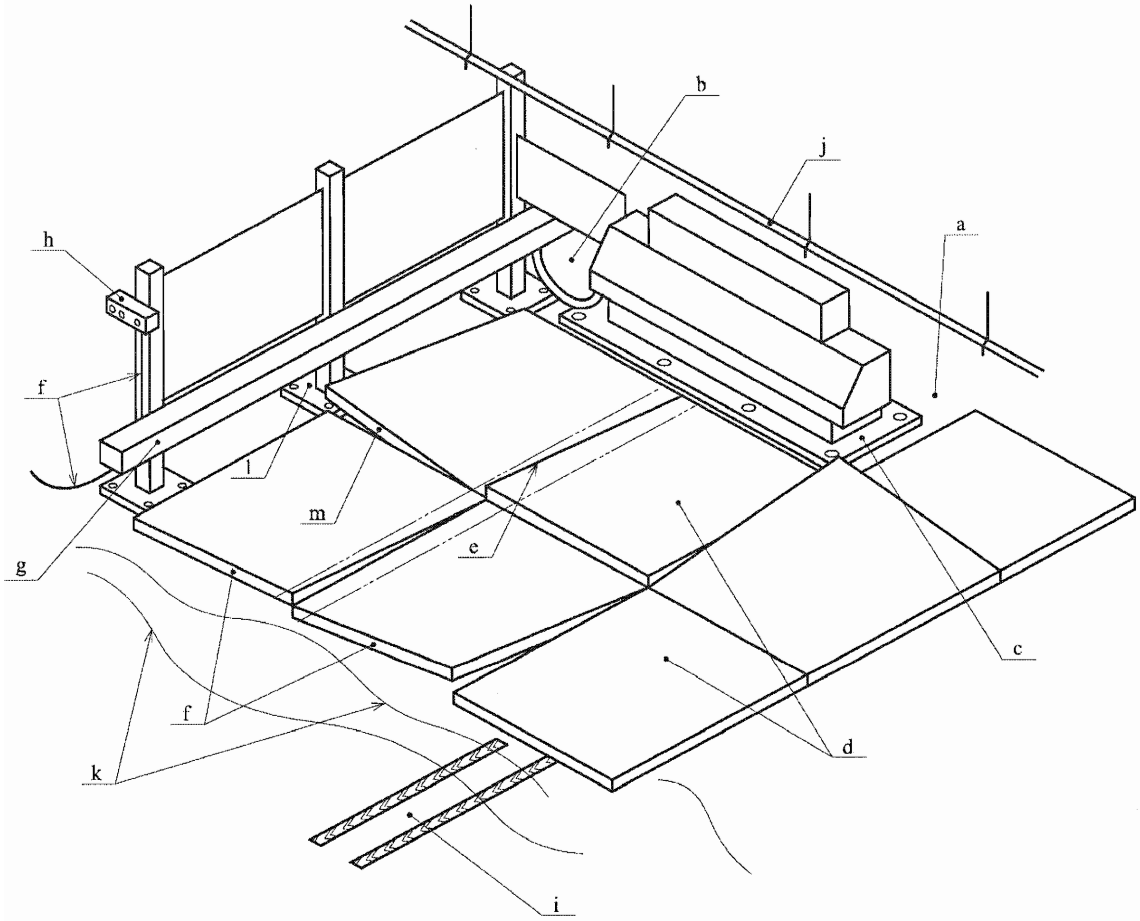
e The dead zones of the sensors are located in such a way that the protective function will not be impaired.

f The tripping hazard at the sensor edge is reduced by a ramp at the point of access. The ramp may also protect connecting cables.

g The cable trunking is installed at the outside of the fixed guard.

h Reset button is located in a well protected location from where the danger zone is fully visible.

Figure B.1 Well-designed installation



a Fixed guards to the danger zone are not sufficient.

b The danger zone is not protected from the rear and is accessible by reaching over and under the fixed guard, which too small.

c The operator can stand on the machinery baseplate in the danger zone.

d The sensors are not property fixed.

e The dead zones of the sensors are located in such a way that the operator can reach the danger zone.

f Tripping hazards presented by exposed edges of sensors and trailing cables: trailing cables are not protected against mechanical damage.

g Cable trunking is installed on the inside of the fixed guard and can be misused to provide access to the danger zone.

h The control unit is installed in a vulnerable position and can be subject to mechanical damage from passing traffic.

i Sensors should not be installed on traffic routes.

j A service pipe installed above the sensors may be misused and consequently swung over the sensors into the danger zone.

k The function and expected service life of the sensors will be reduced due to ground irregularities.

l Access to the danger zone is provided by the baseplates of the fixed guard.

m Sensor not fastened down and presenting a tripping hazard

Figure B.2 Poorly-designed installation

Annex C (informative)
Design notes

C.1 General

These notes should be regarded as a guide to manufacturers, users and testing authorities. Failure to meet the suggestions in these design notes does not necessarily mean that a product is unsafe. It is possible, e.g., that a particular design problem has been overcome in an alternative way.

C.2 Conditions

C.2.1 Frequent actuation

When designing pressure-sensitive mats and pressure-sensitive floors, consideration should be given to the fact that they are also used in applications where they are frequently actuated. In the case of use on production machinery, e.g. when loading a device, more than 3 million operations in the same place can be expected in one year. In the case of pressure-sensitive mats, this can result in a change in sensitivity at the point where the foot is applied.

C.2.2 Infrequent actuation

When designing pressure-sensitive mats and pressure-sensitive floors, consideration should be given to the fact that they are also used in applications where they are only actuated occasionally, at which time they should give reliable operation.

C.2.3 Sensor cables

Where two wires in and two wires out are used to detect cable damage, the wires should be connected at opposite ends of the contact element to ensure integrity through the contact element. If wires are connected close together and there is an open circuit joint on to the contact element, an unsafe situation can arise.

C.2.4 Exceptionally heavy loads

In some situations, heavy loads (such as fork lift trucks) can be applied to the sensor during servicing or tool changing. If this is required, the user should clearly identify the need to the manufacturer/supplier.

C.3 Pressure-sensitive mats

C.3.1 General

The sensor of a pressure-sensitive mat is normally in the form of a sandwich consisting of a top surface, a sensing element and a base.

C.3.2 Sensor surface

The sensor top surface should be of a material which will withstand the operating duty to be expected. In addition, applied forces should not lead to permanent deformation that can form "bridges" over part of the effective sensing field.

The sensor top surface should be of a lifetime non-slip design.

Consideration should be given to the effects of liquids which can be expected to be encountered in the application. E.g. some liquids can cause long-term degradation or swelling which will give rise to an unsafe condition.

C.3.3 Sensor performance

Sensors can have certain areas which are less sensitive than others and also areas which are more prone to damage than others. Sensitivity is often reduced around the edges of a sensor, near the connection point with incoming cables, tubes, fibres or leads and at points where sensing plates are held apart. The specified actuating forces should be taken into account.

Life test should be carried out in areas which are more susceptible to damage and early failure. These include cable entries, joints between the incoming cable and the sensor, and soldered or other connections within the sensor.

C.3.4 Internal air gap

Any gap within the sensor of the pressure-sensitive mat should be kept to a minimum. Ingress of material, either as small or large particles, or vermin or fluid which may be present in the area where the mat is to be used, can cause the sensor to corrode or to lose its sensitivity.

It is not always possible to detect a very small hole in the surface of the pressure-sensitive mat during regular maintenance. However, it may be sufficiently large to allow foreign bodies or fluid into the interior of the pressure-sensitive mat. The larger the air gap, the more foreign bodies, fluid or dirt is likely to enter the gap and form a barrier which prevents the sensor being actuated.

C.3.5 Pressure-sensitive mats with electric sensors

On some designs, electric contact plates are used. The plates are normally separated by an air gap which is closed when a force is applied to the surface. Springs, insulating pads or a resilient foam separate the plates so that the air gap is created. Consideration should be given to the effects of failure of the springs, insulating pads, the resilient foam and the contact plates. Sensor connections should also be considered.

On other types of electric sensor design, the sensor output will vary in a linear manner dependent on applied force. This can be in the form of a variable resistance, capacitance or other effect.

Consideration should be given to the long term stability of variable parts under operating conditions and the effects of ingress of water or other chemicals.

C.3.6 Pressure-sensitive mats with pneumatic sensors

If a force is applied on the effective sensing field of a pneumatic sensor it creates a pressure change as a signal. The time between the application of the force and the signal output depends on the location of the applied force. The longest time should be considered.

C.3.7 Pressure-sensitive mats with fibre optic sensors

When a force is applied to the effective sensing field of a fibre-optic sensor there is a change in the light passing through an optical fibre. Consideration should be given to the long-term changes that can occur in the light emitters and detectors and in the fibre.

At the design stage, care should be taken that no light be able to go directly from the emitter to the detector without going through the fibre.

C.3.8 Connecting cables

In practice, it is foreseeable that sensors may be dragged around by their connecting cables. Consequently, the joint between the connecting cable and the sensor is important. It should withstand both sharp and steady pulls and continuous flexing. Alternatively, a simple means by which the cable becomes disconnected without damage and leaves a safe situation, can be used.

C.3.9 Tripping hazard

A tripping hazard exists when the different in height of adjacent horizontal surfaces amounts to 4 mm or more. Measures should be taken that eliminate the tripping hazard at the surrounding sensor edge. A suitable solution is a ground-flush installation of the sensor, or a ramp with a 20° slope. Sensors that can be combined should be designed in such a way that they do not create a tripping hazard in the combined condition. Lifetime deterioration in hostile conditions should be considered.

C.4 Pressure-sensitive floors

C.4.1 General

Pressure-sensitive floors have a sensor with a rigid, effective sensing field such as fabricated steel plates.

C.4.2 Sensor surface

The sensor top surface should be of a material which will withstand the operating duty to be expected. In addition, applied forces shall not lead to permanent deformation that may form "bridges" over part of the effective sensing area.

The sensor top surface should be of a lifetime non-slip design.

Consideration should be given to the effects of liquids which can be expected to be encountered in the application. E.g., some liquids can cause long term degradation or swelling into an unsafe condition.

C.4.3 Blocking of the contact travel of sensor surface

It could be possible that the movement of the rigid sensor surface can be blocked due to the following reasons:

a) wedging of sensor surface;

b) build-up of foreign bodies such as e.g. swarf, dust and sand under the sensor surface;

c) warping of sensor surface;

d) seizing of guide pins of sensor surface due to corrosion or icing.

C.4.4 Use of limit switches

C.4.4.1 Where limit switches are used in pressure-sensitive floors, they should be selected, positioned and integrated into the control system in such a way that they do not fail to danger (see figure C.1). For further information, see also **5.1** to **5.4** of **JIS B 9710**:2006.

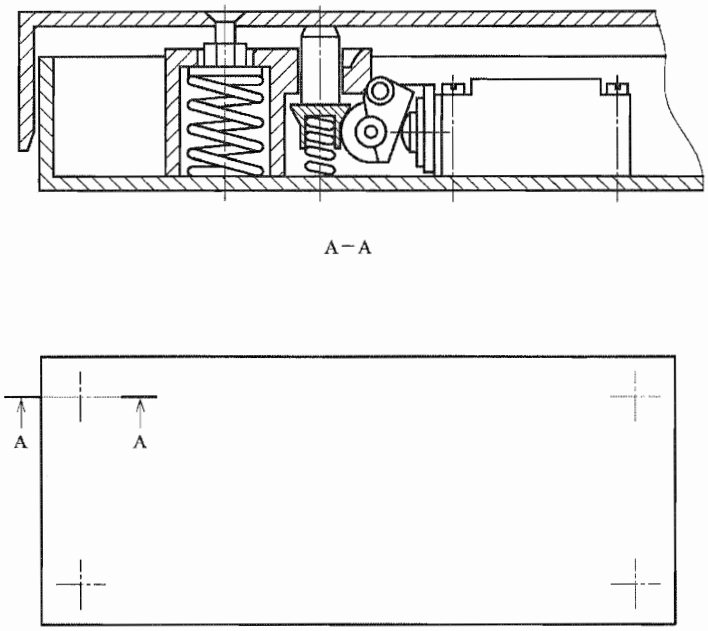


Figure C.1 Use of limit switches

C.4.4.2 Failures of position switches used in pressure-sensitive floors can be caused by:

a) corrosion of limit switches due to the effects of chemicals;

b) blocking of limit switches due to infrequent use;

c) on cam operated systems - excessive wear or misalignment of cams;

d) limit switches loose on brackets causing misalignment.

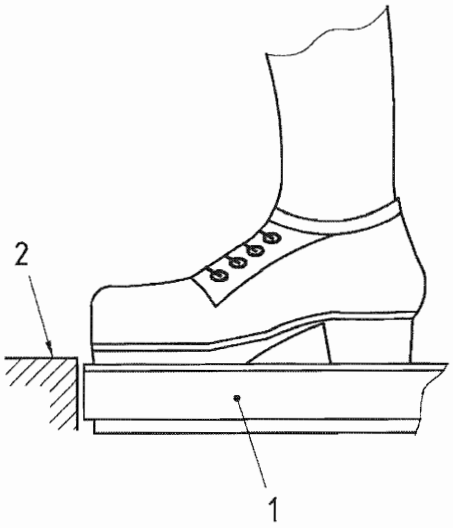
C.4.5 Connecting cables

Connecting cables should be installed in such a way that they do not create tripping hazards or dead zones and cannot be damaged.

C.4.6 Tripping hazard

A tripping hazard exists when the different in height of adjacent horizontal surfaces amounts to 4 mm or more. Measures should be taken that eliminate the tripping hazard at the surrounding sensor edge. A suitable solution is a ground-flush installation of the sensor, or a ramp with a 20° slope. Sensors that can be combined should be designed

in such a way that they do not create a tripping hazard in the combined condition. Lifetime deterioration should be considered in hostile conditions. The movement of the sensor surface should not be so large as to cause a tripping hazard between it and the surrounding fixed surfaces (see figure C.2).



1 Sensor surface
2 Adjacent horizontal surface

Figure C.2 Tripping

C.4.7 Removal of sensor surface

The pressure-sensitive floor should be designed in such a way that it does not fail to danger when the sensor surface is removed.

Annex D (informative)
Installation, commissioning and test

D.1 General

These notes should be regarded as recommendations to manufacturers and users concerning installation, commissioning, testing after installation and regular tests.

All information for installation, maintenance and testing of pressure-sensitive mats and pressure-sensitive floors should be supplied to the user. Recommendations should be given including fixing, lubrication, regular tests and replacement of mechanical and electrical parts. Users should also be provided with appropriate test procedures or systems to check that the pressure-sensitive mat or pressure-sensitive floor is operating within its specification.

D.2 Installation

D.2.1 For correct installation, information about mechanical and electrical requirements for the application and, where necessary, installation drawings should be provided.

D.2.2 The manufacturer should state what technical knowledge and particular skills are required to install the pressure-sensitive mat or pressure-sensitive floor.

D.2.3 Methods of testing and inspection for tests carried out after installation should be described.

D.3 Commissioning

D.3.1 Commissioning should include examination and tests carried out by trained and competent persons.

D.3.2 The results of the examination and tests should be recorded, and copies of this record should be kept by the user.

D.3.3 During commissioning, the following points should be considered.

a) Check that the mounting surface and environmental conditions are suitable for the device(s) in use.

b) Check the minimum distance in accordance with the requirements of **JIS B 9715**:2000

c) Check that the sensor is fastened securely in place and does not provide a trip hazard.

d) Ensure that any "dead zones" do not provide an access path to the hazard.

e) Check that the removal of power supply from the pressure-sensitive mat or pressure-sensitive floor prevents further operation of the machine. The machine should not be capable of being reactivated until power has been restored and the reset operated.

f) Check that a hazardous movement is prevented while an actuating force is applied to the effective sensing area.

g) Ensure that additional safeguards have been provided, where necessary, to prevent access to the dangerous parts of machinery from any direction not protected by the pressure-sensitive mat or pressure-sensitive floor.

h) Check that the presence of a person between the danger zone and the sensor is prevented. If this is not possible, check that further safety measures are taken.

i) Check that all indicator lamps are functioning correctly.

j) Check the sensitivity of the pressure-sensitive mat or pressure-sensitive floor over the whole effective sensing area.

k) The adequate safety required for a machine depends on the safety integrity of the interface between the machine and its protective device(s). Where a category is stated in accordance with **JIS B 9705-1**:2000 by a type C standard or a risk assessment, the checks should ensure the machine control circuits and the connections to the safety device(s) are in accordance with the interface connections agreed between the machine control manufacturer and the safety protective device manufacturer.

l) Where muting is provided, ensure that muting occurs only during the intended part of the machine's operation, e.g. during the cycle where no hazard exists (see **JIS B 9705-1**).

D.4 Regular inspection and tests

D.4.1 It is recommended that regular examination, inspection and test procedures be carried out by qualified and competent persons.

D.4.2 The examination set out in **D.3.3** should be repeated.

D.4.3 During regular inspections check that no modifications have been made to the system and no changes (such as wear to brake pads) have occurred that effect the overall safety of the system.

D.4.4 Check that all control unit enclosures are closed and in good condition and can only be opened by a key or tool. Check that key(s) are removed for retention by designated personnel.

If the equipment fails any of the above tests, it should be isolated and the condition reported and recorded. The equipment should only be re-commissioned after all faults have been rectified.

D.5 Tests after maintenance

After maintenance has been undertaken, a full check of the system as defined in **D.4** should be carried out. Special attention should be given to the function of those parts replaced or repaired.

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[3] EN 1088:1995 *Safety of machinery—Interlocking devices associated with guards—Principles for design and selection*

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